Desktop Catchment Water Modeling

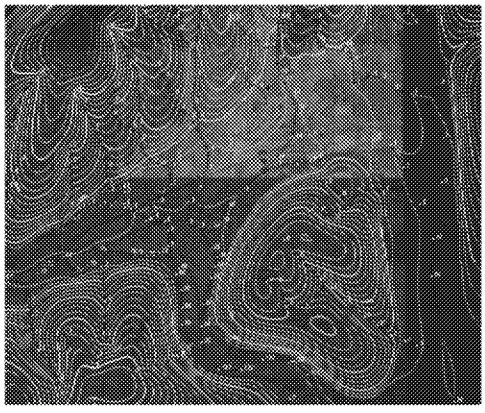
Henry Y. He

Lockheed Martin SERAS

For a long time, traditional groundwater modeling was typically developed after an extensive and time-consuming site investigation was conducted at a particular site because it relies heavily on field data and testing. The new idea of developing a preliminary model *before* going to a site was conceived by U.S. EPA ERT back in 1992 for the Vancouver Well Field contamination investigation emergency response. The modeling results and prediction were surprisingly very consistent with the actual field conditions, observed in the subsequent investigation, remediation, and cost-allocation/litigation efforts. Over the past two decades, this notion of developing a useful model before embarking onto an actual site has gradually evolved into a mature science now called *Desktop Catchment Water Modeling*, with support from U.S. EPA, USGS, watershed organizations, and various major environmental consulting companies.

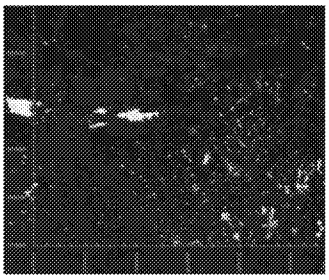
Along this long journey, there have been many significant technology advancements: the internet, email, digital data, online, GIS, satellite-based information, Google Earth, etc. Intertwined with these digital-age inventions, Desktop Catchment Water Modeling has become a highly sophisticated and cost-effective alternative to supplement and streamline traditional field investigation approaches. Over 300 Desktop Catchment Water Models have been developed in 40 U.S. states and 35 countries for clients including 100 of Fortune and Global 500 Companies. It has been applied at various environmental, water resources, impact assessment studies, mining, oil and gas, and construction engineering projects worldwide.

In most cases, for a given location anywhere in the United States or overseas, a Desktop Catchment Water Model can be developed remotely and quickly that generates a long list of modeling results including aerial basemap, topographic contours, drainage network, groundwater contours, groundwater flow lines, aquifer transmissivities of various geologic areas, well capture zones of given pumping rates, groundwater travel time, potential plume down-gradient receptors such as wells, wetlands, streams, springs, shallow unsaturated area with potential off-gas vadose zone impacts, etc. The model has the groundwater aquifer fully interacted with surface stream flows, thus stream flow rate and any given stream location can be developed. The sample modeling result image on the left includes aerial image, traditional map, modeled stream drainage network and stream flow rate, modeled groundwater contours, and well capture zones of several large public water withdrawal wells and a residential well. The modeling resutls were later field verified with the observed water level within 6-inches of that modeled.

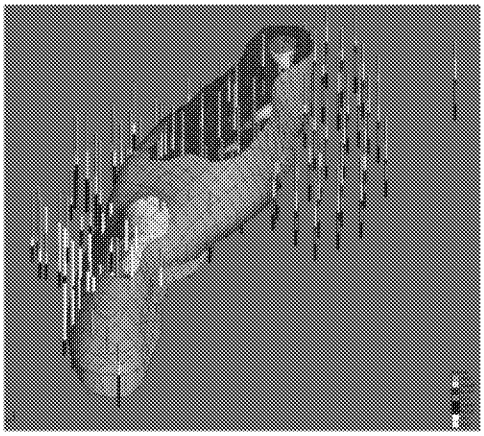


The catchment-scale modeling is based on the principle of complete natural water balancing cycle within a catchment or catchments and requires the entirty of a catchment basin(s) to be included in a single model. Once a labor-intensive effort, the catchment modeling now has become cost-effective as modern GIS-based satellite data became readily available over the past decade. The largest model that has been developed covered a 250,000 square kilometer area (overall area of New York and Pennsylvania combined) in Africa

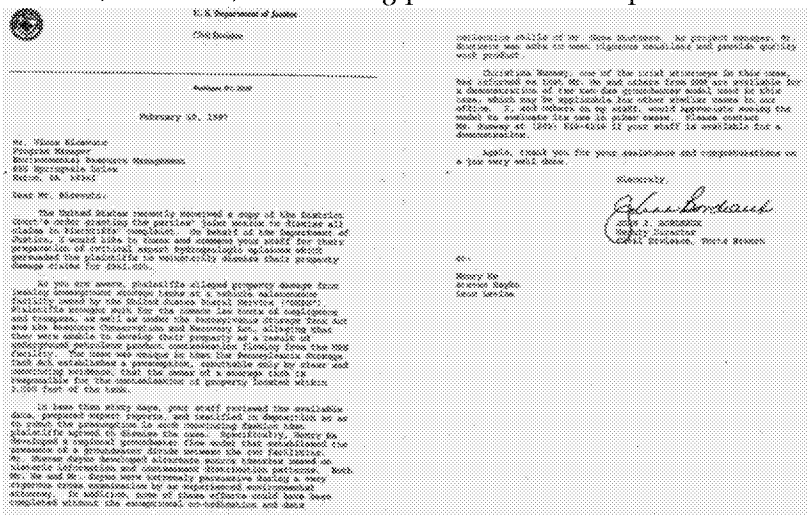
as the natural catchment basin extends to such an extent. Billions of digial and online data were obtained and used to supplement limited site data. The figure on right shows remote sensing results of small water bodies that function as equavelent water level data in monitoring wells, utilized for the modeling. The advaced model code also allows zooming into a local site area with infinite high resolution, despite the large overall model extent.



With reliable water balance and natural catchement watershed extents and boundaries, the Desktop Catchment Model modeling often provides a much more suitable framework for localized 3-D groundwater flow modeling, contaminant fate and transport modeling, densive-drive plume modeling, coastal salterwater intrusion, etc. Altough this advanced modeling does require certain field data, the amount of fied data needed is much less than those required by tranditional groundwater modeling. The image on left presents a snap of a modeled 3-D plume migration history animation of complex desity-dependant TPH plumes. Also presented are 3-D boreholes with geological stratifications, highlighting the brilliant graphic capabilities for site visualization and animation. The Desktop Catchement Water Modeling has been successfully applied at 40 Superfund and NPL-listed sites which posed most challenging situations. It has been accepted by U.S. EPA, state againcies, international regulatory againcies, and had passed vigorous international and US peer-reviews.



Many of these models had been verified by field data subsequently including in some of the most challenging geological enviroments such as fractured bedrock, karst flow, and bedding-plane-controlled aquifers. One successful story about this technology was the U.S. Postal Service VMF lawsuit case in Pittsburgh, Pennsylvania. Represented by U.S. DOJ, the USPS had offered a settlment earlier but it was declined by the Plaintiff. A Desktop Catchment Water Model was developed quickly and showed a natural waterdivide that separated the Plaintiff's property from the USPS' facility. The Plaintiff later withdrew the case only after realizing the data acquired subsequently from more than 20 temporary soil boreholes were remarkably consistent with the modeling results. U.S. DOJ Deputy Director of Civil Division Joan J. Bordeaux issued a formal commendation letter (right) on this matter.



Desktop Catchment Water Modeling is now available at Lockeed Martin SERAS Contract under U.S. EPA ERT. For more information, please contact Henry He at (484) 983-1904, henry.y.he@lmco.com; henry.he.modeling@gmail.com and Donald Bussey of U.S. EPA ERT at (702) 612-7163, bussey.don@epa.gov.